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THE UNIVERSE OF SUNS.

By RICHARD A. PROCTOR.

ALTHOUGH we are placed at present in a far more advantageous position for forming an opinion respecting the constitution of the heavens, than any of those who have in former ages inquired into this subject, yet we cannot afford to neglect any of the hints thrown out by men like Galileo and Huyghens, Wright, Kant, Lambert, and Michell. Moreover the account of former hypotheses respecting the universe is full of interest.

The ideas of ancient astronomers respecting the stars were naturally very far from the truth. Anaximenes regarded the stars as studs on the crystalline sphere, while Theophrastus supposed that the celestial sphere consists of two distinct halves fastened together along the Milky Way, but so imperfectly that we can see through the unclosed spaces the luminous heavens beyond. Xenophanes taught that the stars are clouds collected in the upper regions of the air, and fed from the fiery æther. Hence the remark of Callimachus that the circumpolar stars feed on air; and hence the question of Lucretius, "*Unde æther sidera pascit?*" Anaxagoras considered that the stars, as well as the sun, moon, and planets, were rocks swept off from the earth by the æther, and kindled to an intense heat in the fiery upper regions.

Passing, however, from these vague fancies, let us turn to those hypotheses which were formed when the Copernican theory enabled men to form some conception of the enormous distances of the fixed stars, and when telescopic researches began to reveal vast numbers of stars hitherto unseen by man.

Copernicus himself occupied a somewhat exceptional position, since he was the only astronomer who ever theorised respecting the stars on the basis of the system which bears his name, but without the knowledge respecting unseen stars which his successors obtained by means of the telescope. It should be noticed also in considering the views of Copernicus, that though he had abandoned the Ptolemaic astronomy, he had by no means abandoned the artificial conceptions on which Ptolemaic astronomy had been based. That this is so, can be recognised even in the account which Copernicus gave of the motions within the solar system; it is still more apparent in his remarks respecting the universe. "It is to be observed in the first place," he says, in his treatise "De Revolutionibus," "that the universe is spherical; not only because that is the most perfect of all figures, needing no fastening or junction, complete in itself; but because it is the most capacious figure, fittest to enclose and preserve all things; because the most perfect portions of the universe,—the sun, moon, and stars,—are seen to have that shape; and lastly because, as we see in drops of water and other liquids, all things capable of assuming the figure they prefer, select the figure of a sphere." Of the sphere of stars, however, he remarks only, that it is the outermost and chief of all the spheres, immovable because enclosing all other spheres.

Galileo, the first Copernican to recognise the enormous extent of the stellar regions to which the unaided eye cannot penetrate, formed no theory respecting the universe. He saw clearly, however, the extreme importance of those revelations made by the telescope, and their bearing on the theories men had formed respecting the Galaxy. "It is truly a wonderful fact," he said, "that to the vast number of fixed stars which the eye perceives, an innumerable multitude, before unseen, and exceeding more than tenfold those hitherto known, have been rendered discernible. Nor can it be regarded as a matter of small moment that all disputes respecting the nature of the Milky Way have been brought to a close, and the nature of this zone made manifest not to the intellect only, but to the senses."

Kepler was the first astronomer who enunciated definite ideas respecting the constitution of the universe. In 1618, or nine years after the publication of the two first of the laws which bear his name, he published the first three books of his "Epitome," the fourth in 1620,* a year after his third law had been published in his *Harmonia Mundi*. The following statements have been extracted from the "Epitome" by W. Struve, and form a fair abstract of the ideas of Kepler:—

The sun lies farther from the fixed stars than these lie from each other. Within the sphere of the fixed stars there is a vast concavity girt round on all sides by the stars. The sun lies within this space, so that the solar system occupies an exceptional position in the universe. The concavity enclosing the sun lies also near the centre of the zone called the Milky Way. This is shown by the fact that the Milky Way appears as a great circle on the heavens, and sensibly of uniform brightness throughout. The space occupied by the stars, limited on the inside by the concavity enclosing the sun, is also limited on the outside, and thus forms an immense spherical shell, outside of which lies *space* † The sun is the chief body—the *heart* of the universe,—whence flow light and heat; he is also the ruler of the planets and their satellites. The sphere of the fixed stars is as the *skin* of the universe preventing the escape of the solar heat and reflecting the solar light. It is therefore as of ice, by comparison with the fiery mass of the sun. The stars according to this hypothesis are much smaller than the sun, but shine with their own light, the light of each having its own proper colour.‡

* Not 1622, though the title-page bears that date.

† Kepler bases this conclusion on the same reasons which Copernicus had already alleged.

‡ He admits, however, that the sun may possibly be only a star, brighter because nearer than the rest; and that the other stars may be surrounded, like our sun, with planetary schemes. "This, however," he remarks, "is not a necessary inference from the Copernican system, which decides nothing respecting the nature of the fixed stars. We are therefore free to admit that the fixed stars are spread, as the Hebrew tradition asserts, within a stratum comparatively thin and of a watery nature, and that this stratum is crystalline, the water in it being frozen on account of its great distance from the sun, the centre of the heat of the universe."

But the most remarkable part of Kepler's speculations is that in which he determines the dimensions of the sphere of the fixed stars. It affords a striking illustration of his strange faith in numerical analogies; a faith however accompanied by that perfect desire to ascertain the truth which had already caused him to abandon one after another a series of many such relations, suggested by his poetic imagination while he was dealing with the solar system.

The radius of the concavity enclosing the sun was determined by a simple proportion. Saturn the outermost planet travels at a distance from the sun equal to 2,000 times the sun's radius. Therefore by the harmony of relations, the distance of the sphere of the fixed stars is equal to 2,000 times the distance of Saturn from the sun. *This enormous distance is confirmed by the observations of Tycho Brahé which show no annual displacement of the stars as the earth sweeps round her widely-extended orbit.* But the thickness of the crystalline shell can also be determined. All the matter of which the universe is formed is divided into three equal parts. One third is included in the body of the Sun. Another third forms the substance of the planets and of the celestial æther which fills up the space within the sphere of the fixed stars. The remaining third forms the Crystalline. Now since the æther fills a space exceeding the sun's volume 64 trillions of times [$(4{,}000{,}000)^3$], its density must be proportionately small compared with his. And the density of the crystalline must needs be a mean between the sun's density and the æther's. Thus the crystalline has a density 8,000 million times less than the sun's; and as its mass is equal to the sun's its volume is 8,000 million times greater. Hence it is easy to calculate its thickness, which is found to be equal to the 6,000th part of the sun's radius.* So that according to the modern determination of the sun's dimensions, Kepler's theory assigns to the crystalline a thickness of but about seventy miles!

Struve remarks very justly that these ideas of Kepler's, fanciful though they are, yet merit attention, because they contain the germ of modern views respecting the universe. This remark relates specially, it would seem, to the passage which is italicised, and to the admission presented as a note. Struve adds that it would even seem as though Kepler had sought only to accommodate the Copernican theory with the ideas entertained in his day respecting "the waters above the firmament," spoken of in the Pentateuch. *(To be continued.)*

Blackwood's diaries for 1884 are again before the public, some of them having been started twenty years ago. [I have used the "Six Days' Diary" for twenty years.—R. P.] They now number over thirty varieties, so as to meet the wants of every person keeping a diary, as every one should. Most of these diaries contain three maps, an almanack with events and dates, and calendars for 1884-5. All information is officially corrected; the prices range from 1d. to 12s. The sale is very large, in one case 50,000 yearly.

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* Struve says 60,000, probably from his own calculation, as he proceeds to employ the modern estimate of the sun's distance. But the number should be 6,000. The calculation proceeds thus,—The volume of the sun is equal to one-third of a cylinder having a base equal to the sun's surface and a height equal to his radius; and the volume of the crystalline is equal to a cylinder having the surface of the crystalline for base and the thickness of the crystalline for height. The surface of the crystalline exceeds the sun's (according to Kepler) 16 billions of times—so that the volume of the last named cylinder would be 48 billions of times larger than the sun's if its height were equal to his radius. But its volume is in reality but 8,000 million times larger than the sun's. Hence its height must be the 6,000th part of the sun's radius—48 billions containing 8,000 millions 6,000 times.

LADYBIRDS.

By E. A. Butler, B.A., B.Sc.

Ladybirds are beetles; or, in other words, their organisation and developmental history are of the same type as those of the Stag Beetle, Dung Beetle, Colorado Beetle, and a host of other similar creatures. They have no connection with the fleet-footed and foul-smelling household pests commonly though erroneously called "Blackbeetles," and more correctly named "Cockroaches." These are not beetles at all, but in consequence of great differences both in structure and style of development, are to be referred to quite a different order, that, namely, which includes grasshoppers, crickets, &c. To satisfy oneself as to the zoological position of ladybirds, a specimen should be dissected, or at any rate so arranged as to display all its external organs. Suppose now a good-sized ladybird is before us, say one with seven large black spots on its red arched back. We place the creature with its flat side downwards and then observe that the upper part is readily divisible into three areas, slightly movable upon one another. The first, which is the smallest, is the head; besides the organs of the mouth, which will be referred to further on, it carries two tiny, many-jointed clubbed appendages, which are the antennæ, and two great masses of eyes, one on each side. No such thing as a neck is visible, and the head seems sunk in the second part of the body, the edge of which forms almost a continuous curve with that of the head. This second part, the prothorax, is considerably wider than the head, and much arched, like a long narrow shield thrown across the body and excavated a little in front to receive the head. Behind this comes the greater part of the insect, but here we get to greater complexity; we find that the arched back is not solid; we note a central longitudinal line of division, and on dexterously inserting a needle here discover that we can raise and move somewhat aside each of the halves at their outer extremity, but that at their other end they are hinged to the body. They are now seen to be two horny curved shields, stout and stiff, and capable of covering completely two more delicate membranous wings which are folded up underneath them, one on each side. These, on being unfolded, are found to be rather more than twice as long as the space in which they lie, or as the shields which protected them; they are brownish in colour, and flexible, and are folded transversely in the middle, and the outer half is turned back underneath the basal part. They are the true organs of flight, and when the ladybird takes to the wing, as it might be tempted to do in bright sunshine, the upper shields are merely raised to give free play to the wings, and are not themselves vibrated. Underneath the wings we come to the real body, which, when the insect is not flying, is completely concealed above under the great arching shields.

Turning the creature over on its back, we see that the underside is nearly flat, and is altogether differently coloured from the upper part; the six short legs are capable of being folded up, joint upon joint, and packed away so neatly in slight hollows excavated for their reception that when thus closed they scarcely interrupt the general level of the surface, and are rendered quite invisible from above.

The organs of the mouth are so small that they require considerable care in their examination. A fine needle will be found useful in opening them out, and a hand lens in making out their form and arrangement. Beginning from above we find, under a broad, overhanging kind of lip, a pair of stout, broad, horny jaws, or mandibles, each

ending in two sharp points; they move sideways and close upon one another like a pair of shears. Next come a pair of more delicate jaw-like organs, the maxillæ, each of which carries a large, jointed appendage, the maxillary palpiss, the last joint, the largest, shaped something like an axe-head; these hatchet-like pieces are by far the most conspicuous objects in the head. Between the maxillæ is a thin plate, the labium carrying another and smaller pair of jointed organs, the labial palpi. Now the presence of the pair of horny sheaths covering the transversely-folded membranous wings and the structure of the organs of the mouth, which are adapted for biting, and not for sucking or licking juices, are characteristics of the order of beetles; and so, if a stag-beetle, dung-beetle, Colorado beetle, or other member of the order be examined, the wings and mouth will, as a rule, be found to be constructed on the same plan.

Like other beetles, too, ladybirds pass through a series of remarkable transformations during their brief life. The parent insect lays her yellow eggs on some plant infested with aphides, or blight, as they are popularly called. From the eggs emerge little six-footed creatures of a slaty colour, sprinkled with yellowish dots, and further ornamented with a number of warts or tubercles. They attack and make short work of the aphides, and grow fat upon the diet. But after a while, a great change occurs; the grub becomes transformed into a pear-shaped body, wholly devoid of limbs, and attached by the smaller end to a leaf or some other support. In this condition it remains for a time perfectly quiescent; then the skin bursts, and there creeps forth a limping, soft creature, in form a ladybird, but in consistency something like a boiled pea. Exposure to the air after a time hardens its skin and at the same time deepens its colour, and then we have the adult ladybird fully equipped for setting about the great task of the perpetuation of its kind. When on the wing it flies vigorously, but it is a poor pedestrian, walking at no great rate and with no very certain steps, and ready at slight provocation to tuck its legs in close to its body and feign death, in which condition it may be tossed about without manifesting any signs of vitality. This is not its only means of protection, for it is able to exude a yellow oily fluid of powerful and rather offensive odour, and no doubt of equally unpleasant taste. This must make it an extremely nauseous morsel to any foe that has the temerity to attempt to make a meal of it. Not only during its grub-like babyhood is it the ruthless destroyer of aphides, when it has assumed the responsibilities of adult life the old taste still persists, and the war of extermination is prosecuted with vigour, those bifid mandibles forming excellent weapons for tearing to pieces the bodies of the sluggish but luscious plant-lice. It must therefore be reckoned as one of our insect friends, and its frequent presence in large numbers in hop-gardens will be regarded with satisfaction, when we remember how peculiarly liable the hop-plant is to the attacks of aphides.

Our British fauna can boast of about a score of species of ladybirds. Some of these are very abundant, others scarce; some are very constant in their coloration, others vary so much that it is difficult to find two specimens exactly alike. In some species the spots are black on a red or yellow ground, in others cream-coloured or yellow on a black or dark red ground. The spots may be either round or angular; they are generally simple, but in one or two instances are surrounded by a ring of another colour. Finally, one species has no spots at all, but a distinct black M-like mark on the thorax. The spots vary in number in the different species, but are, as a rule, remarkably constant in different specimens of the same species. Thus there are species with 2, 5, 7, 11, 12, 13, 14, 16, 18, 19, and 22 spots respectively, that is, reckoning only those that adorn the wing-cases. The commonest of all is that which has two spots, one on each wing-case; its usual coloration is black spots on a red ground, but sometimes the black spreads so as to almost entirely cover the back, leaving only two shoulder-spots of red, and the insect then looks so different that it is difficult to believe that it is the same species. Some species, the most handsome of the group, are specially addicted to fir-trees; others occur in damp places, and some few, such as the two and seven-spotted forms, may turn up anywhere.

CAVERNS IN EARTH AND MOON.

By Richard A. Proctor.

AS I find few points in my views about the future of the Earth-World received with more difficulty than my statement that the waters of the sea, if they should eventually retreat into the earth's interior, as Sir Isaac Newton suggested, could certainly never retreat into cavities—seeing that "such cavities could no more exist in the solid frame of the earth than within the mass of an ocean," I take pleasure in quoting some remarks by Mr. W. Mattieu Williams, bearing very pertinently on this matter,—as well as some remarks relating to limestone caverns, showing one of the ways in which waters once above the earth find their way below its surface. It will be inferred from Mr. Williams's words that some persons, presumably Oxonians or Cantabs, have recently been advocating the preposterous theory of which he so effectually disposes. And although it may seem to many that the theory requires no answer, being inherently too absurd for belief, I know from experience that the case is otherwise. Many who have spoken to me after my lecture on the "Life of Worlds" have shown that they still retain a vague hankering for this impossible view, which associates itself conveniently with Sir David Brewster's explanation of the small density of the external planets.

I may add that the capacity of some persons for starting off with a full and complete idea—as they suppose—of a special theory, from perhaps a casual and blundering remark about it in some newspaper paragraph, would be regarded by many as absolutely incredible.

It will be observed that Mr. Williams in touching on the theories which he himself advanced in his ingenious, though rather crude, "Fuel of the Sun" speaks of them with great confidence,—a tone not usually sustained as advancing study teaches the limited nature of our knowledge, and the utter impossibility of forming any widely extending theory (especially a theory of the universe). That however need not prevent the reader from accepting the grains of real information conveyed in what follows. The "perpetual motion" theory, which underlies what Mr. Williams suggests as to the unvarying condition of the several orders of bodies in the universe, seems, oddly enough, acceptable, on a very large scale, to those who would laugh at it if advanced in regard to mechanism on some more appreciable scale, — who might even invite the inventor of the mechanism, as Robert Stephenson did in such a case, to carry himself round the room by the waistband of his own trousers and *then* explain his perpetual motion. Mr. Williams's wider perpetual motion (really but a much magnified mistake) might lead rude persons to suggest a more heroic achievement,—he might be asked to convey himself by the afore-mentioned waistband on a lecture tour round the world and *then* try to establish the perpetual mechanism of suns and sun systems, and (as an additional trifle) the amazingly im-

possible mode of generation of solar systems which he has advanced in his "Fuel of the Sun." But these wild fancies of a mind really most practical in terrestrial matters, are not our present (or likely to be our future) game. What follows, apart from references to such matters, is well worth studying, and especially useful reading for those Cantabs or Oxonians who seem to have advocated the doctrine of monstrous internal lunar or terrestrial cavities:—

"'The Curiosities of Science' would form a subject for quite as thick a book as Disraeli's 'Curiosities of Literature.' Whoever may write it should devote a full chapter to the hypotheses of the moon's senility, Jupiter's juvenility, the earth's middle age, the cooling down of the sun and stars, and the general dying out of the universe." [Another might be devoted to theories of perpetual motion, on whatever scale imagined.]

"A full discussion of this subject would far outrun the limits of a note, but I may remark, in passing, that I have stated in 'The Fuel of the Sun' my reasons for concluding that our sun and solar system, and all the other suns, systems, and nebulæ within the reach of human observations, have during all time within the limits of human conception been on the average just as hot and as bright as at present, though subject to a fluctuation both up and down; and that Jupiter, Saturn, Uranus, and Neptune were always minor suns, and must always continue to be such." [Perpetual motion on a large scale is very properly put, "in passing," as a striking illustration of the idea broached in the preceding paragraph].

"A branch of the dismal hypothesis now in fashion is the supposition that the moon was formerly a verdant world with land and sea, rivers and lakes, atmosphere and clouds; and that by internal shrinking, which its crust has not followed, there are caverns as big as its former oceans, and so deep that all their waters and all the ancient lunar atmosphere are swallowed into them; that our earth will ultimately grow old, will die, and become as cavernous inside, and as arid and airless outside, as the moon is now.

"That such a dream should occupy the waking hours of men living on this planet, and knowing something of the properties of the materials of its surface, is curious indeed. Had they been educated in a colliery instead of Cambridge or Oxford, they could not possibly have been deluded by any such monstrous physical fable.

"They would have known that when a cavity of notable horizontal area is formed anywhere in the crust of this earth, whether 20 yards, 50 yards, 100, 200, or 500, or 1,000 yards or more below the surface, the mere weight of the superincumbent rock squeezes itself down until the roof of the cavity touches the floor; and that the permanency of any such a cavity (or its existence even for a year or two) is a physical impossibility.

"So inevitable is this that in the old mode of coal working by 'pillar and stall' a deplorable waste of coal occurred. 'The pillars of coal that are left to support the roof form frequently as much as three-fourths, and never less than one-third, of the whole seam' (Tomlinson). A portion of these are finally removed, but in order to protect the miners artificial wooden pillars or 'juds' are supplied to support the roof. When these are removed, the roof falls in by the bending down of the hundreds of yards of rock above, and shivering of the immediate surface of the roof.

"If those who believe the moon to be the abode of caverned oceans and atmosphere, and who imagine that our earth will follow its example, would make a pedestrian trip through the Black Country between Birmingham and Wolverhampton, under which the great ten-yard coal seam formerly existed, the spectacle of leaning chimney shafts, split cottages, and toppling houses would show them what would happen *if* the interior shrinkage of the earth produced but very remote approaches to their imaginary caverns.

"The most remarkable of these effects is that of the yielding—I say 'flowing'—of the rock not immediately over the removed coal. The area of the superficial sinkage basin is considerably larger than that of the hollow filled up, but, of course, proportionately less deep. From this it follows that houses not actually undermined are sometimes wrecked or damaged. 'Sunnyside,' near Caergwrle, Flintshire, a house occupied by a friend of mine, was split down through the middle while his family were in occupation. It was well built and of good size. Had it been a London suburban villa of the ordinary Jericho order of architecture the consequences would have been serious. As it was, he deliberately moved to another house, and Sunnyside was left until the subsidence was completed, when the chasms in the wall were filled up by the proprietors of the colliery, whose workings had only approached but had not reached it. This is merely one example, hundreds might be quoted.

"In modern 'long wall' working the coal is removed by working away from a long face of coal at the boundary farthest from the pit, then approaching the pit in a long line, supporting the part where the men are immediately at work. As soon as the distance from the original wall exceeds a certain extent the roof collapses, and thus the collapse follows the workers.

"If such puny excavations cannot exist, how monstrous is the assumption that caverns capable of swallowing the Atlantic Ocean could remain for even half an hour!

"Natural caverns rarely attain the span of Brunelleschi's dome, or that of the Albert Hall, and never reach that of the Midland Railway station at St. Pancras, unless supported by stalactites and stalagmites. A multitude of proofs of the limits of their possible area is afforded by their collapse, cases of which (like Daddy Hole Plain, Torquay) may be traced in almost every great limestone district. At earth depths corresponding to maximum ocean depths, not only great caverns but even minute filtration pores are impossible, as proved by the experiments of Spring, described in my notes on 'Regelation and Welding' (August, 1882), and on 'Transfusion by Pressure' (February, 1883).

"As the origin of natural caverns is not generally understood, I may supplement the above note with a short explanation.

"Generally speaking, they occur in limestone rocks. There are a few exceptions, such as that on the Island of Thermia (Greece) in argillaceous schist, and those on Etna formed by the hardening of lava during the escape of pent-up vapour, but such exceptions are very rare; while, on the other hand, there are very few ranges of compact limestone where caverns are not more or less abundant.

"Take a little clear lime-water in a wine-glass, and blow through it by means of a glass tube, a quill, or tobacco-pipe. It becomes turbid by the conversion of the soluble caustic lime into insoluble carbonate. Most of the limestone rocks have been formed by chemical action nearly resembling this precipitation.

"Now continue the blowing, and the further supply of carbonic acid will ultimately dissolve the carbonate of lime it first precipitated. This is the action that excavates the limestone caverns.

"Rain-water picks up a little carbonic acid on its way through the air, then more and more as it flows over vegetable matter. Thus charged it dissolves, slowly it is true, but surely, the most compact limestone. I have walked

through a few miles of natural tunnelling in the marble mountains of Carrara.

"In limestone districts small rivers are in the habit of suddenly disappearing, and breaking out in fresh places a few miles distant. A legion of legends are based upon these, that of Alpheus and Arethusa being the most popular and typical. When I visited the fountain of Arethusa it was the public laundry of Syracuse, and not one nymph, but above a score of nymphs were there. It is a considerable stream, that breaks out through a limestone tunnel directly on the sands of the sea-shore.

"There are about half-a-dozen of such subterranean streams in the Craven district of Yorkshire, and more than a dozen in Ireland.

"The solvent power of the water reaches its maximum when it has oozed through a peat bog. The river connecting Lough Mask with Lough Conn is a striking example of this. Its subterranean evolutions are most complex, and the hard limestone is riddled with caverns of all sizes, from little holes affording winter quarters for solitary toads to the show caverns that are duly exhibited to tourists for a consideration.

"An absurd result followed from this condition of the rock. A canal for extending the inland navigation from Lough Corrib to Lough Mask, thence to Lough Conn and the Moy River to Killala Bay was projected, thus connecting Galway Bay with the Bay of Donegal. The canal was actually cut in the hard rock between the lakes, and finished all ready for filling. When the water was admitted it disappeared, and the cutting now remains as a costly tributary to a subterranean river."

EVIDENCES OF THE GLACIAL PERIOD.

IT is hoped that this paper may be useful alike to those who have no acquaintance with geology and to those who have some knowledge of that science. To the former, its chief object will be to enumerate in a brief summary—"plainly worded, exactly described"—the evidences which have led geologists to the belief in a Glacial Period; while to the latter it may not be altogether useless as a convenient summary of such evidences. The writer, therefore, begs the indulgence of his readers if in some cases he has been somewhat elementary and given to repetition, for which his only apology must be the desire to make the truths of science plain and clear to all.

When we see the ruins of a house with charred timbers and blackened walls, we conclude at once that that house has been burnt by fire. It does not matter if we have not seen the fire ourselves, or if no one has told us about it; we still feel certain that fire has been at work, simply because we know from experience that it is in the nature of fire to char timbers and blacken walls, and because we know of no other cause capable of producing those results.

It is by a precisely similar train of reasoning to the above that we feel certain that glaciers or rivers of ice once ploughed their way down our English valleys, and that a covering of solid ice once enveloped the whole of England. We believe this because throughout England are marks upon the scenery of the country which glaciers and ice are elsewhere producing to-day, and which we know of no other cause capable of producing in England during the past, except that of the same agents of glaciers and ice; therefore, we conclude that these agents did formerly exist in England, and we give to the time when such was the case the name of the Glacial Period.

In order that our readers may be able to verify this conclusion for themselves we shall now describe a few of those marks in the scenery to which we have referred as being produced by glaciers.

(1.) *Moraines.*—In Switzerland, where glaciers exist at the present day, wherever those glaciers occupy the valleys, moraines are found. These moraines are composed of fragments of rock, large and small, which, having become detached from the adjoining hill-sides, roll down on the glacier, and are carried along by it, forming long continuous lines of blocks and fragments along its sides. When this accumulation is found along the sides of glaciers it is termed a *lateral* moraine; when, owing to the junction of two glaciers from separate valleys, two of these side or lateral moraines unite to form a central line of blocks and fragments, the latter is called a *medial* moraine; and when a glacier comes to an end through having descended into regions too warm for its existence, and where it is melted away, a vast heap of rubbish brought down by the glacier is thrown down at its termination, which is called a *terminal* moraine. Now, exactly similar lines and heaps of blocks and fragments are found in our English valleys, and as we know of no cause capable of producing them except glaciers, it is only reasonable to suppose that those found in England are due to the same causes as in Switzerland, and therefore we come to the conclusion that, although glaciers do not now exist in England, they did formerly, and then produced those moraine lines and heaps which we now find in our valleys.

(2.) *Polished and Striated Rock Surfaces.*—When a glacier passes over a rocky surface, it polishes and makes the same quite smooth and bright. Sometimes it makes scratched markings upon such surface. This is done by pieces of hard and sharp rock which have got frozen into the glacier, and such markings are generally pretty near parallel and in the same direction, consequently showing the direction in which the glacier is moving. Now very many of these polished and scratched rock surfaces are founded in England, and as they present an identical appearance with those found in Switzerland, it is but reasonable to set down both to the same cause—namely, glaciers.

(3.) *Erratic Blocks.*—At many places in Yorkshire may be seen large boulders of granite, mountain limestone, &c., several tons in weight, some being of exactly the same material as that composing the mountains of Cumberland. In fact several boulders of granite to be seen lying on the cliffs of Yorkshire have evidently been derived from Shap Fell in Cumberland. Now the question arises, how have these very heavy boulders been brought down from Cumberland to Yorkshire? For a long time this question was a perfect puzzle, until it was observed in Switzerland that large boulders had been carried down from the Alps by glaciers and spread over the plains below, in some cases extending as far as the foot of the Jura mountains. Here, then, was the clue to the mystery. A power had been discovered capable of removing immense and heavy blocks of rock for long distances—that power was the glacier; and as no other power but moving ice was known capable of removing these heavy blocks, it became evident that it could only have been ice which had removed these huge blocks of Shap Fell granite to their present place on the Yorkshire plains and cliffs. From these "erratic blocks," as they are called, being dispersed all over England, and not always in a line with the present valleys, it is concluded that during the severer portions of the Glacial Period, England not only had her valleys filled with glaciers, but that the whole country was "moulded" in ice, from the higher portions of which, such as these Cumberland mountains, erratic blocks were dispersed in all directions.

(4.) *Perched Boulders.* — When a glacier, owing to gradual softening of climate, melts away, it leaves the huge masses of rock it has borne down very often "perched" in very peculiar positions, so peculiar that we know of nothing capable of placing huge blocks of stone in such positions, except receding glaciers. Very many of these "perched boulders" may be seen in Britain, especially among the mountains of Scotland and Wales, evidently left in their present position by glaciers which have now disappeared.

(5.) *Scored and Rounded Mountains.* — These same mountains of Scotland and Wales by their scored, rounded, or worn flanks, present an identical appearance with mountains elsewhere where the very same appearance is produced by ice. Consequently the tale they tell of the former action of ice is obvious.

(6.) *Dome-shaped rocks.*—When huge masses of rock lie in the bed of a glacier, they become so worn and rubbed by the glacier that they assume a dome-shaped form, bearing a fanciful resemblance to the backs of a flock of sheep, and hence called in French "*roches moutonnées.*" These dome-shaped rocks are found plentifully in all countries where glaciers exist to form them, and as they are found plentifully in Yorkshire and elsewhere in England, the conclusion is irresistible that glaciers once existed to cause them in our own land.

I think it will be clear from the foregoing marks in the scenery of the country which I have enumerated and described, that the evidence for the existence of a Glacial Period in the Northern Hemisphere generally (for these marks are not confined to England, but are found over the whole of the north of Europe, and in the United States and elsewhere in America) is of exactly the same kind as the evidence afforded by a house that has been burnt. For just as charred timbers and blackened walls tell us plainly that *fire* has been at work, so moraines, polished rock surfaces, erratic blocks, perched boulders, scored and rounded mountains, and dome-shaped rocks tell us plainly that *ice* has been at work. Although we may neither have seen the fire that burnt the house, nor the glacial ice that left these marks, although there may have been no eye-witnesses in either case, still this does not affect our conclusion; for just as we know that fire, and fire only, produces the appearances we see in a burnt house, so we know that ice, and ice only, produces those marks in the scenery which have been enumerated. Therefore, we conclude that, wherever those marks are found, ice, and ice only, has caused them.

Striking as these evidences are of the existence in England and the northern hemisphere generally of a Glacial Period, they are by no means the only evidences. Besides these six several features in the scenery which may be grouped together under the head of Inorganic Evidences, we have in addition thereto Organic and Collateral Evidences. We will look at each of these somewhat in detail in our next article. Robert B. Cook.

CHEAP AND GOOD FOOD.*

By T. R. Allinson, L.R.C.P.

ALLOW me to bring under the notice of your readers some experiments I have just concluded to solve the difficulty of feeding our poor in London and elsewhere. The cry is that food is so dear the poor can scarcely live. This cry is true if they want to live on luxuries, but if they will live on wholesome but plain and healthy fare they can do so for very little. A little over a month ago I determined to give up all expensive articles of food and live almost as cheaply as possible. Having left off flesh foods for nearly two years, and lecturing frequently on the question of food, I knew what to select. Looking over my food accounts, I found milk, butter, eggs, and cheese, with tea and coffee were fairly expensive articles, and none of them necessary, so I gave them up for a time to see results. On October 19 I began my experiment; my weight was then 9 stone 8 ounces. I continued this purely vegetarian diet for a month, when my weight was 9 stone 3 pounds 12 ounces, or a gain of 3¼ pounds. My friends said I looked well; I felt well, and did my usual work the same as ever. I walked from 10 to 15 miles daily, seeing patients or taking exercise. Here is an account of my dietary, which cost me little more than sixpence a day, and I could easily live for less without luxuries:—Breakfast consisted of a basin of porridge, made from a mixture of oatmeal and wheatmeal, which I found more palatable than either singly. This I usually eat with bread to insure thorough insalivation. Then came bread fried in refined cotton-seed oil, or fried vegetable haggis. For drink I had a cup of cocoa or fruit syrup, with warm water and sugar. The cocoa used was an ordinary one with plenty of starch in it, which makes a thick drink, and no milk is then required. Dinner consisted of a thick vegetable soup and bread, potato pie, savoury pie, vegetarian pie, vegetable stew, stewed rice and tomatoes, &c. For a second course I had bread plum-pudding, stewed rice and fruit, baked sago, tapioca and apples, stewed prunes, figs, raisins, and bread. Tea meal consisted of bread and jam, stewed fruit, or some green stuff, as watercress, celery, tomatoes, &c. I had only three meals a day, and frequently, when very busy, I had only two, and a cup of cocoa and a biscuit for supper. I always use the whole-meal bread, as it is laxative and contains a good deal of nitrogen, which is thrown away with the bran. The cotton-seed oil is a cheap and good cooking oil, and is impossible to detect. This diet I continued for a month, and now I only take the animal products when out, not having them at my table.

Now compare this diet with one of flesh or a mixed one. The latest analysis shows flesh to contain from 70 to 74 per cent. of water, the dry residue being very rich in nitrogen, and it contains a little carbonaceous or fatty matter. Hence, to live on meat alone, as much as 8 lb. a day is necessary. Then there are to be considered the diseases of animals which are communicable to man if that flesh be not thoroughly cooked all through, and as very few of our animals live a perfectly natural life, most of them are more or less diseased, especially the fat ones. The excess of nitrogen taken into the system in eating flesh meat has to be got rid of by the liver, kidneys, and lungs; hence these organs are overtaxed, and much disease is the consequence. In fact, were it not for flesh food we doctors should have very little to do. Man living in towns cannot afford to eat much flesh, because he does not get sufficient exercise and oxygen to burn up the excess of nitrogen. If he does eat this flesh, and if he eat much, then he must suffer from many complaints, such as indigestion, bilious attacks, congested liver, hæmorrhoids, gastric catarrh, and other gastric troubles. If the habit be continued in, gall-stones or urinary calculi may follow, or rheumatism and gout. Then the kidneys become diseased and more work is thrown on the heart, which becomes also diseased; the end is death by one of the lingering diseases, which shows a diseased organ somewhere. Even epilepsy and many nervous diseases are aggravated by flesh. Cancer is on the increase, and, from some observations I have made, it may be

* From a letter to the *Times* by our valued correspondent, T. R. Allinson, L.R.C.P.

indirectly traced to flesh. Consumption has only a remote connection with flesh, it being due chiefly to want of fresh air. Vegetable food is cheap, contains an abundant supply of nutriment at first cost, and our systems are so formed as to use it with least expenditure of vital force. We use no cruelty in obtaining our food, and can easily see if it be wholesome or in a rotten state.

By means of our diet much disease is prevented, and even most chronic cases of present disease can be alleviated by it. If we want a cheap dietary we have the following foods to choose from:—Wheat, oats, barley, maize, rice, sago, tapioca, semolina, hominy, peas, beans, lentils, &c., which are all concentrated foods, and very rich in nutriment. Potatoes, parsnips, beets, carrots, turnips, onions, cabbage, sprouts, &c., give variety, bulk, and flavour; to these may be added the sweet herbs for making savoury dishes. Apples, pears, currants, gooseberries, plums, strawberries, rasps, blackberries, and other fruits, with melons, peaches, grapes, &c., are high-priced, but wholesome fruits. The dried fruits, as dates, figs, apple rings, currants, raisins, &c., are cheap and good. To these may be added tinned goods. Thus one can see the immense variety of tasty things we have, and these to suit all purses. We can add to these milk, butter, cheese, eggs, and honey, which are got without killing animals. But if we take animal food, then fish is least injurious, then beef and mutton, while veal, pork, game, &c., are very indigestible, and ought to be avoided.

RECREATION THROUGH UNCERTAINTY.*

IF we look for the characteristics which may be found in all good active recreations, and on which their utility chiefly depends, we shall find that they all include one or more of these three things: namely, uncertainties, wonders, and opportunities for the exercise of skill in something different from the regular work. And the appropriateness of these three things seems to be, especially, in that they provide pleasant changes which are in strong contrast with the ordinary occupations of most working lives, and that they give opportunity for the exercise of powers and good dispositions which, being too little used in the daily business of life, would become feeble or be lost.

In their daily work—speaking generally and roughly—most people become tired of routine and sameness; they know their business, and there is in it little to surprise them; they can reckon on what is coming; they know how and when each day's work will end. They get tired of all this, and wish for something very unlike it; and so they long for uncertainties; they enjoy to watch something they are not sure of, to see the settlement of a doubt, the unveiling of a mystery.

Herein is a great part of the refreshing change, the recreation, found in games of chance. The toss of a halfpenny brings refreshment to the routine of the school-boy or the errand-boy in that every time he tosses he creates an uncertainty, enjoys it for a moment, and then decides it. To the elder man the deal at whist and every hand he plays bring similar pleasure in uncertainties; and the counting of the tricks decides them; and the pleasures and uncertainties accumulate to the end of the rubber or of the whole evening's play. Other pleasures mingle with these; the exercise of skill, the reckoning of chances, and many more, including, perhaps, the winning of money or repute; but with them all and under them is the occupation in uncertainties, and its pleasure is the more refreshing the more it is in contrast with sameness in the daily work.

Doubtless there is much of the same pleasure in all sports; in fishing, shooting, and the like. Will the fish bite? Will the bird fall? There is the uncertainty; and then comes the decision; and in any case, hitting or missing, the mind which has been wearied in a dull routine is refreshed. It is the same in cricket and lawn-tennis, and all the like popular games. Mingling with the other pleasures that they give, and the other good they do, there is the refreshing pleasure of a continuous succession of uncertainties and decisions, a pleasure which seems to reach its acme in some of the amusements that are attended with frequent risks of limbs or even of life The contrast with the ordinary occupations of vast crowds of all ranks and ages and occupations is complete; and from this contrast comes a great part of the true recreation, the re-fitting for the work. Doubtless, some of the refreshment of reading novels and romances, whether real or in fiction, is of the same kind. Else, why should nearly every one who reads them feel that his pleasure is marred by hearing what the end of the story is, and by thus having his uncertainty prematurely settled?

These may be examples enough. I believe that if any one will think over the whole class of what are fairly called active recreations, he will find that a chief part of nearly every one is of this kind: the unveiling of a mystery, the issue of some chance, the settlement of an uncertainty. Every one who works enough to need or deserve refreshment should see that some of his recreations have in them this element; and let him observe that of all the recreations of this kind those are the best which, together with the element of uncertainty or chance, offer the largest proportion of that element of which I spoke—the opportunity of exercising skill. In all games and sports the more the results depend on chance, and the less they depend on the skill of the players, the more is the gambling. Duly guarded, the love of recreation among uncertainties may lead to the promotion of admirable skill, whether of mind or limbs; and if, on the one side, it may make itself vile by gambling, on the other it may ennoble itself by strengthening the mental disposition which moves men to experiments in science, and even to the highest methods of research. In all these a great part of the happiness is in the watching and decision of uncertainties, in the unveiling of hidden truth; and all whose work gives them too little opportunity for such happiness should have it in their play.

* From an article by Sir James Paget in the *Nineteenth Century*.

THE AMATEUR ELECTRICIAN.

BATTERIES VII.

A HANDY form of bichromate battery, in which the solution is kept in motion, is that constructed by Mr. Higgins, of the Exchange Telegraph Company. Its distinctive feature is in the earthenware containing-jar, which is supplied with a small lip on the upper edge. The cells are arranged on a series of shallow steps, and are placed as close together as possible. Above the highest cell is a small tank or reservoir containing the solution, which is discharged drop by drop. As the drop falls into the cell, a drop is expelled from it into the next cell below it, and similarly the second cell discharges a drop into the third cell. In this way there is accomplished a continuous motion in each cell, and it is maintained that there is a considerable increase in the constancy of the cell in conse-

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quence. Whether, however, it is sufficient to warrant structural alterations in the battery room or not is, perhaps, an open question. It will answer many purposes to which the amateur wishes to apply his battery, more particularly in those cases where a powerful and approximately steady current is required.

M. Trouvé has also tried to increase the constancy or steadiness of the current from a single fluid bichromate. He turned his attention to the solution, which is prepared by dissolving three ounces of bichromate of potash in twenty ounces of boiling water, and, after cooling, adding gradually nine ounces of sulphuric acid, stirring the solution as the acid is introduced. A stronger solution is in this way prepared, and, according to M. Hospitalier, the current is steadily maintained for five hours if the zincs are gradually immersed deeper and deeper in the solution. No sane man would, however, maintain that such an arrangement could be regarded as a practical one—one, that is to say, which could be called upon at a few minutes' notice to do work either on a small or on an extensive scale. The intensity of the current is but two volts per cell; less, that is, than can be obtained from another form, to which we shall now turn.

When Gerritt Smith arrived in England for the purpose of trying the American system of quadruplex telegraphy, it was found that the Daniell cell—which till then had enjoyed almost exclusive tenancy of the Post-office battery-rooms—would not, unless subjected to very extensive modifications in size, yield a current such as would work the system efficiently. The form of cell used in America was unsuited to English ideas. The result was that resort was made to a cell offered by Mr. Fuller, and which bears his name. Several thousand Fuller cells are in use throughout the country, there being no fewer than seven thousand in the Central Telegraph Office alone. Fig. 1 illustrates

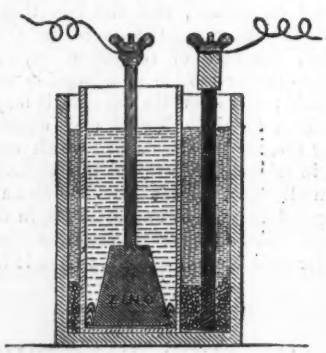


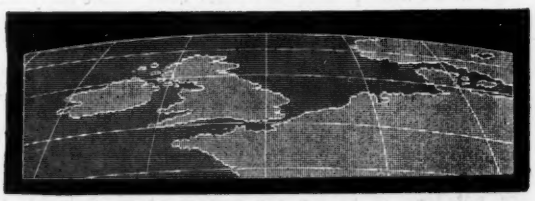
Fig. 1.

the construction of the cell, which consists of a zinc rod of peculiar shape, cast on to a thick copper wire, placed in the porous pot, and a small carbon plate capped with lead and fitted with a binding screw in the outer or containing earthenware jar. The shape given to the zinc is to compensate for unequal consumption, and to facilitate its amalgamation, which is brought about automatically. The comparatively large size of the outer vessel, which is generally 6 inches high and 4½ inches in diameter, while the carbon is only 2 inches, is to allow a large quantity of bichromate solution to be employed, and so to save time in renewing or recharging, and to minimise polarisation. The cell is charged by placing in the porous pot dilute sulphuric acid in the proportion of nine of water to one of acid, and in the outer jar a strong solution of bichromate of potash, with about 10 per cent. of sulphuric acid added. Great as is the stir made when we are told that certain batteries are constant for four, five, or six hours, the Fuller cells are frequently called upon for longer periods. In quadruplex telegraphy a current is always on the line—that is to say, so long as the circuit is being worked; and thus it is that the cells are giving a practically uninterrupted current from 7 a.m. till 6 p.m., or perhaps later, day after day for weeks, without requiring any serious attention. It is, of course, only fair to point out that the resistance offered by a telegraph circuit is as a rule much higher than in experimental circuits, a fact which operates very materially in favour of the battery, because with a circuit of very low resistance—say half a mile of copper wire of about the same thickness as a common pin—the current is proportionately larger, or capable of producing greater thermal effects, and the battery, as a consequence, is more speedily exhausted.

Where delicate apparatus is employed, or where the battery circuit is frequently broken and re-made, considerable danger results from the use of batteries of low resistance. For example, it frequently happens that 40, 60, and even 80 cells are used on a circuit, the resistance of which is, perhaps, 5,000 Ohms, or more. Supposing, now, that the wire suddenly breaks and falls to the ground, or that some other of the many ills that an aërial telegraph line is heir to takes place, then the battery, if the fault happens to be close up, will be practically short-circuited, the current immensely increased, and the platinum contacts in the instruments fused; or, if any coils happen to be in the circuits, as is the case in some systems, they stand a good chance of being fused, and so rendered useless. To prevent this as far as possible, the porous pots used in the telegraph service are painted with a very thin coating of an insulating material, so as to raise the internal resistance of the cell to 2 Ohms.

We should have said something concerning the latest of the many proposals to use bichromate batteries for electric lighting, but this we must defer till another opportunity presents itself.

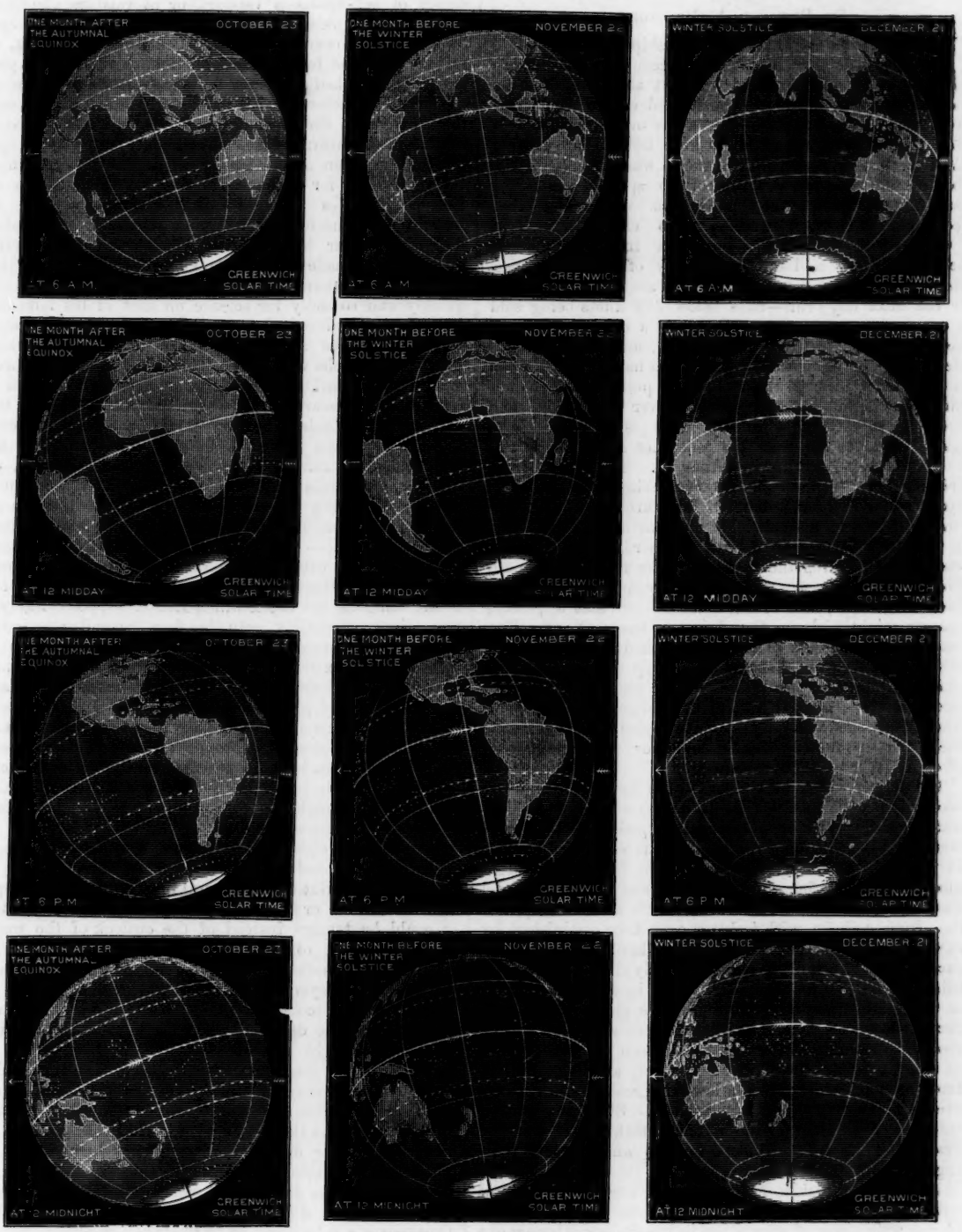
SUN VIEWS OF THE EARTH.



View of the British Isles, France, &c., as seen foreshortened from the Sun in Winter.

National Health Society.—At a meeting of the society on the 11th inst. it was decided to assist, as far as possible, the useful work now carried on by the Sanitary Aid Committee. These are being started in several parts of London in connection with the local committee of the Charity Organisation Society. The National Health Society will issue shortly a handbook for the use of sanitary-aid visitors, explaining in simple terms the existing laws between tenants and landlords, and the leaflets and pamphlets already published by the society will also be of great service.

ONE MONTH AFTER AUTUMNAL EQUINOX. | ONE MONTH BEFORE WINTER SOLSTICE. | AT THE WINTER SOLSTICE.



SUN VIEWS OF THE EARTH;

OR, "THE SEASONS ILLUSTRATED."

By RICHARD A. PROCTOR.

I GIVE this week the Sun Views for the month, showing the aspect of the earth as supposed to be seen from the sun at six in the morning, noon, six in the evening, and midnight, Greenwich solar time, at the winter solstice. For comparison, the Sun Views for October and November are repeated. We add a picture of the British Isles, &c., as seen from the Sun at the Winter Solstice.

SCIENCE AND SAFETY AT SEA.

By Richard A. Proctor.

IN the Autumn of 1879 the steamship *Arizona*, 5,000 tons, at that time the swiftest ocean-going steamship in existence, was urging her way, at the rate of some fifteen knots an hour, on the homeward course from New York, whence she had sailed but a day or two before. It was night, and there was a light haze, but of danger from collision with a passing ship there was little or none. The captain and crew knew of no special reason for watchfulness, and the passengers were altogether free from anxiety. Indeed, it so chanced that at a time when, in reality, the most imminent danger threatened every soul on board, many of the saloon passengers were engaged in purchasing at auction the numbers for the next day's run—runs below 350 knots being sold at a very low rate indeed. Suddenly a crash was heard, the ship's swift progress was stopped, and a few minutes later every one knew that the *Arizona* had run dead upon an enormous iceberg, the spires and pinnacles of which could be seen hanging almost over the ship, and gleaming threateningly in the rays of her masthead light. But the risk that threatened her living freight was not that of being crushed by falling ice. The bows of the *Arizona* were seen to be slowly sinking, and presently there was a well-marked lurch to starboard. The fore compartment and a smaller side compartment were filling. It was an anxious time for all on board. Many an eye was turned towards the boats, and the more experienced thought of the weary miles which separated them from the nearest land, and of the poor chance that a passing steamer might pick up the *Arizona's* boats at sea. Fortunately, the builders of the *Arizona* had done their work faithfully and well. Like another ship of the same line which had been exposed to the same risk, save that her speed was less, and, therefore, the danger of the shock diminished, the *Arizona*, though crippled, was not sunk. She bore up for St. John's, and her passengers were taken on later by another steamer.

The danger which nearly caused the loss of the *Arizona* —collision with an iceberg—is one to which steamships, and especially swift steamships, are exposed in exceptional degree. Like this danger, also, it is one which renders the duty of careful watching, especially in the night and in times of haze or fog, a most anxious and important care. But, unlike the risk from collision with another ship, the risk from collision with icebergs cannot be diminished by any system of side lights or head lights or stern lights, except in just such degree (unfortunately slight) as a powerful light at the foremasthead, aided by strong side lights or bow lights, may serve to render the gleam of the treacherous ice discernible somewhat further ahead. But to a steamship running at the rate of fourteen or fifteen knots an hour, even in the clearest weather, at night, the distance athwart which which a low-lying iceberg can be seen, even by the best eyes, is but short. She runs over it before there is time for the watch to make their warning heard and for the engineers to stop and reverse their engines.

But science, besides extending our senses, provides us with senses other than those we possess naturally. The photographic eyes of science see in the thousandth part of a second what our eyes, because in so short a time they can receive no distinct impression at all, are unable to see. They may, on the other hand, rest on some faintly luminous object for hours, seeing more and more each moment, where ours would see no more—perhaps even less—after the first minute than they had seen in the first second. The spectroscopic eyes of science can analyse for us the substance of self-luminous vapours, or of vapours absorbing light, or of liquids, and so forth, where the natural eyes have no such power of analysis. The sense of feeling, or rather the sense for heat, which Reid originally and properly distinguished as a sixth sense (not to be confounded, as our modern classification of the senses incorrectly confounds it, with the sense of touch), is one which is very limited in its natural range. But science can give us eyes for heat as keen and as widely ranging as the eyes which she gives us for light. It was no idle dream of Edison's, but a thought which one day will be fraught with useful results, that science may hereafter recognise a star by its heat, which the most powerful telescope yet made fails to show by its light. Since that was said the younger Draper (whose loss followed so quickly and so sadly for science on that of his lamented father) has produced photographic plates showing stars which cannot be seen through the telescope by which those photographs were taken. As yet the delicate heat-measurers devised by science have not been applied to astronomical research with any important results. But Edison's and Langley's heat-measurers have been used even in this way, and the very failure which attended the employment of Edison's heat-measurer (the tasimeter, or, literally, the strain measurer, described shortly before in the *Times*) during the eclipse of 1878 shows how delicate is the heat-estimating sense of science. When the light of the corona — which has no heat that the thermometer, or even that far more delicate heat-measurer, the thermopile, will recognise—fell on the face of the tasimeter the index which Edison supposed likely to move just perceptibly actually flew beyond the index-plate. Thus, though the heat of the corona could not be measured, the extreme delicacy of the tasimeter was demonstrated unmistakably. Langley's heat-measurer is scarcely less sensitive, and probably more manageable. But in point of fact each instrument is more sensitive than the heat sense of science is required to be, to do the work I have now to indicate; and an instrument can readily be constructed which shall be, in the right degree, less sensitive than they are, though it might be difficult at present to invent any that should be more sensitive.

The sense of sight is not the only sense affected as an iceberg is approached. There is a sensible lowering of temperature. But to the natural heat sense this cooling is not so obvious or so readily and quickly appreciated that it could be trusted instead of the outlook of the watch. The heat sense of science, however, is so much keener that it could indicate the presence of an iceberg at a distance far beyond that over which the keenest eye could detect an iceberg at night; perhaps even an isolated iceberg could be detected when far beyond the range of ordinary eyesight in the daytime. Not only so, but an instrument like the thermopile, or the more delicate heat-measurers of Edison and Langley, can readily be made to give automatic notice of its sensations (so to speak). As those who have heard Professor Tyndall's lectures any time during the last twenty years know, the index of a scientific heat-measurer moves freely in response either to gain or loss of heat, or, as we should ordinarily say, in response either to heat or cold. An index which thus moves can be made, as by closing or breaking electrical contact, or in other ways, to give very effective indication of the neighbourhood of danger. It would be easy to devise half a dozen ways in which a heat indicator (which is of necessity a cold indicator), suitably placed in the bows of a ship, could note, as it were, the presence of an iceberg fully a quarter of a mile away, and speak

of its sensations much more loudly and effectively than the watch can proclaim the sight of an iceberg when much nearer at hand. The movement of the index could set a fog-horn lustily announcing the approach of danger; could illuminate the ship, if need be, by setting at work the forces necessary for instantaneous electric lighting; could signal the engineers to stop and reverse the engines, or even stop and reverse the engines automatically. Whether so much would be necessary—whether those among lost Atlantic steamships which have been destroyed, as many have been, by striking upon icebergs, could only have been saved by such rapid automatic measures as these, may or may not be the case; but that the use of the infinitely keen perception which the sense organs of science possess for heat and cold would be a feasible way of obtaining much earlier and much more effective notice of danger from icebergs than the best watch can give, no one who knows the powers of science in this direction can doubt.—*Times*.

Editorial Gossip.

I regret to say that two members of the Faculty, to wit my family doctor and a doctor specially skilled in matters relating to railway accidents and their effects, regard with disapproval the efforts I have made during the last few months to disregard Nature's warnings. The fact is, the London and South-Western Railway Company have endeavoured so earnestly to persuade me that I am none the worse for the shock they kindly gave me last July that I have tried to persuade myself I might not be so much the worse for it as I seemed to feel. Anyway, I am now relegated to two months, at least, of absolute repose from mental work. Fortunately, there is enough collected material, so far as my share in Knowledge is concerned, for longer than that; and I believe readers will find no other effect but the omission of "Short Answers" and "Editorial Gossip"—perhaps (if some correspondents are to be believed) an improvement rather than otherwise. I shall ask those who stand by Knowledge to continue their support till I am fairly on my feet again. That they have done so, indeed, during the last few months, when I have been as good as on my back (or as bad?), says much for their good will.

Some physical results of the Java disturbance help us to understand how small the world is. Take a bowl of water, agitate the fluid in the centre, and the undulations you excite propagate themselves in smooth-swelling concentric rings till they lap against the sides of the bowl. There they break, and slop up in mimic tidal waves. This is an exact illustration—*magna componere parvis*—of the oscillations of the sea reported from both hemispheres this week. The tidal irregularities, as might be expected, were most violent on the north-western seaboard of Australia, which lies right opposite the scene of the Java disturbances. On that coast the sea retreated and advanced a hundred yards. A day or two later oscillations appeared on the Atlantic seaboard of America. The particular undulation which, on the fifth day out, slopped up on the East coast of New Zealand, must have come by way of the Cape of Good Hope and Cape Horn, and had nearly completed the circuit of the globe. Australia lies as a breakwater between us and Java by the direct route. It gives one a new conception of the littleness of what Henry Ward Beecher calls "this fipenny-ha'penny world" when a man can stand on the Ocean Beach at Dunedin and watch the ripples from a splash made in the Straits of Sunda.—*Otago Times*.

THE FACE OF THE SKY.

From December 20, 1883, to January 4, 1884.

By F.R.A.S.

Whenever the winter sky is sufficiently clear, the Sun should be examined for spots. The mist near the horizon will now often enable this to be done with a very light coloured eye-shade on the telescope. Map XII. of "The Stars in their Seasons" exhibits the present appearance of the night sky. Mercury is still, for all practical purposes, invisible, as is Venus also. The position of Mars improves nightly, as he rises soon after eight on December 20, and about seven o'clock in the evening by January 4. By the latter date his diameter will have increased to 15″. He is still perceptibly gibbous, *i.e.*, as we have previously explained, not round. He continues in the western part of Leo ("The Stars in their Seasons," Map. III.). Jupiter, the gem of the night sky, rises about 6h. 22m. this evening, appearing above the horizon, of course, earlier and earlier every night; until by the 4th prox. he rises at 5h. 24m. p.m. His diameter increases during this interval from 41″·7 to 42″·6. He continues in Cancer, at some little distance to the west of the Præsepe (same Map). The phenomena of his Satellites visible before 1 a.m. during the next fourteen days are tolerably numerous. And first, to-night, the young observer should carefully watch as much of the Transit of Satellite IV. across Jupiter's face as he can. The Satellite will leave Jupiter's disc at 11h. 5m. p.m. We have referred on page 350 to the curious phenomena often witnessed in connection with the Transits of the outer Satellites, and less frequently seen when the inner ones cross Jupiter's face. On the 21st, Satellite III. will disappear in eclipse at 34m. 48s. after midnight. The shadow of Satellite I. will enter on to the planet's limb on the 23rd, at 10h. 22m. p.m., followed by the Satellite which casts it at 11h. 1m. p.m. The shadow will pass off at 12h. 42m. p.m., the Satellite not until between 1 and 2 o'clock the next morning. The next night (the 24th), the same Satellite, I., will disappear in eclipse at 7h. 33m. 44s., pass behind the body of the planet, and reappear from occultation at 10h. 29m. p.m. On the 25th Satellite I. passes off the limb of the planet at 7h. 47m. p.m.; as does Satellite III. at 8h. 35m. Satellite II. disappears in eclipse at 8h. 39m. 24s. p.m. on the 26th, to reappear from occultation 43 minutes after midnight. On the 28th, Satellite IV. will suffer eclipse at 9h. 40m. 21s. p.m. Sixteen minutes after midnight on the 30th the ingress of the shadow of Satellite I. will begin, the Satellite following it half an hour later. On the 31st, the same Satellite will disappear in eclipse at 9h. 27m. 25s. p.m., reappearing from occultation at 12h. 13m. The night of January 1, if fine, will be a prolific one for the student. The ingress of the shadow of Satellite I. will occur at 6h. 45m., followed by that of Satellite I. itself at 7h. 12m. p.m. The transit of Satellite III. will begin at 8h. 20m.; the shadow of the 1st Satellite leaves Jupiter's face at 9h. 4m., as will the Satellite casting it at 9h. 32m. Then the shadow of Satellite III. will quit the limb of the planet at 10h. 4m., Satellite III. itself passing off at 11h. 55m. On Jan. 2 Satellite I. will reappear from occultation at 6h. 39m. p.m., and Satellite II. be eclipsed at 11h. 15m. 28s. Lastly, on Jan. 4 the egress of the shadow of Satellite II. will happen at 8h. 19m., as will that of the Satellite from which it proceeds, at 9h. 6m. p.m. Saturn is still visible during the whole of the ordinary observer's night. He rises this afternoon (the 20th) about 2h. 23m., and is on the meridian at 10h. 16·9m. p.m. By Jan. 4 he will south at 9h. 14·0m. in the evening, rising about 1h. 27m. in the afternoon. All the leading details of his physical structure are now admirably visible with sufficient optical power. Uranus will scarcely come within the ken of the great mass of amateur observers before February next. The direction we gave a fortnight ago (p. 350) will enable any one to find Neptune who cares to do so. Pons's Comet is now brightening with tolerable rapidity, and may be seen with the naked eye. If we draw an imaginary line between γ and 35 Cygni, the Comet to-night will be very nearly on this line, about three-quarters of the distance between the larger star and the small one. It will be close to ζ Cygni on the 27th. By Jan. 4 it will have travelled down into Pegasus. The Moon's age at noon to-day is 20·7 days; and, evidently, at the same hour on Dec. 29, 29·7 days. Then she will be one day old on the 30th at noon; and, of course, six days old at noon on Jan. 4. She will not rise to-night until a quarter to twelve o'clock; and, as she does so later and later every day, the nights up to the end of the year will be practically moonless. No occultations of stars occur during our specified period. The Moon is travelling across the south-eastern part of Leo to-day, and enters Virgo at midnight. It takes her until 11 a.m. on the 24th to cross this large constellation, and at that hour she passes into Libra. Her passage through Libra occupies 48 hours, and at

11 a.m. on the 26th she enters the narrow strip which forms the northern part of Scorpio, and having crossed this, at 11 p.m. enters on to her path through the southern part of Ophiuchus and Serpens. By 6 p.m. on the 28th she quits Serpens for Sagittarius, whence she passes, at 5 a.m. on the 31st., into Capricornus. At midnight on the last night of the year she enters Aquarius. She does not leave Aquarius until about 7 p.m. on January 3rd, when she travels into Pisces. We there leave her.

"Let Knowledge grow from more to more."—Alfred Tennyson.

Only a small proportion of Letters received can possibly be inserted. Correspondents must not be offended, therefore, should their letters not appear.

All Editorial communications should be addressed to the Editor of Knowledge; *all Business communications to the* Publishers, *at the Office, 74, Great Queen-street, W.C.* If this is not attended to delays arise for which the Editor is not responsible.

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The Editor is not responsible for the opinions of correspondents.

No communications are answered by post, even though stamped and directed envelope be enclosed.

A BLUE MOON.

[1056]—On December 4, at 4.30, p.m., I was summoned by an observant assistant (Mr. T. H. Dean) to see a "blue moon!" Sure enough, the moon's crescent was of a steely, greenish-blue—"electric blue," I believe the precise tint is called. The setting sun was marked by coppery-red stratus clouds; elsewhere cumulus prevailed, with patches of blue sky. The phenomenon only lasted for some ten or fifteen minutes. I should attribute it to matter (capable of absorbing the red rays) suspended in the upper regions of the atmosphere. The sun's rays having to pass twice through these upper layers of air, were reduced at last to the blue end of the spectrum only. That most of this finely-divided, suspended matter may have been derived from the fearful volcanic eruptions which occurred some time back in the East Indian Archipelago, I have no reason to doubt. At least, I have not yet heard of any more feasible theory. W. Jerome Harrison.

36, Lodge-road.

[The theory that the blue and green sun and moon and recent strange sunsets have been due to the volcanic eruptions near the Sunda Straits, requires,—(1), that much more should have been expelled than was apparently expelled (to spread so widely); (2), that to reach Trinidad, Panama, and Yokohama the expelled matter should have travelled from sixty-five to seventy-five miles per hour, but have gone in quite leisurely fashion to Ceylon and South India. I fancy we all thought Krakatoa had something to do with the matter when we had the news from Ceylon. But now I think every one who has studied the evidence in full and is competent to form an opinion perceives that the theory has become altogether untenable. Professor Piazzi Smyth, I see, holds as Mr. Ranyard does, that meteoric dust explains all the phenomena.—R. P.]

STRANGE SUNSETS AND BLUE MOON.

[1057]—Pardon me intruding on your time, and perhaps on your space, but might I suggest a use of aëronautics to solve, perhaps, to some extent, the at present insoluble recent solar and lunar phenomena? We know how Gay-Lussac and Biot in 1802, and afterwards Gay-Lussac himself, at a height of 22,000 ft. above Paris, or four miles and a quarter above the level of the sea, intrepidly experimented on magnetism, hygrometry, &c. Whatever the dust pervading the space contiguous to our earth may be, surely at such a height some of it might be collected and examined in the same way as atmospheric dust has been collected and examined, as described in a past article in Knowledge. Is there no one of those who make aëronautic voyages as a pleasure who will place their experience and apparatus at the disposal of scientific men—that is to say, if they think such a course likely to meet with any success?

Unluckily Mr. Raynard's article appeared just after the first fall of snow, with his suggestion to analyse it, in order to ascertain whether a greater quantity of dust were present than usual. I trust that he has done so, and will give us his results.

In that unsatisfying article in the *Daily News* of the 8th inst. the writer has attempted to explain the green moon by the pinkish colour of the sky beyond it. A friend of mine, however, at Red Hill, states that he saw the crescent moon green on Wednesday, 5th inst., at 5.10 p.m. on the ordinary starry background, and *not* on a pink background. He says that as it sank in the west it assumed the reddish colour. Edward A. Martin.

STRANGE SUNSET.

[1058]—At Montrose, as at other places, the remarkable "afterglow" has been observed, and the following observations of it at Montrose may prove interesting to Mr. A. C. Ranyard and your readers.

1. I observed it first here on the evening of Sunday, Nov. 25, when the sky was filled with a deep red colour, looking very like (as I at first supposed it to be) a very bright Aurora. The glow continued in the sky at every sunset, with more or less intensity, for the whole week, and on Nov. 30 it attained its maximum (so to speak), for, just as the sun set, the whole sky was filled with colours of the most brilliant hues: on the horizon was a band of bright yellow streaked across its centre transversely by another of green, while overhead the sky was of an orange colour, gradually merging into brilliant red. That same morning a "preglow" of as great intensity as the afterglow was observed. For the next three days, Dec. 1, 2, 3, it was foggy and dull, and on the evening of the 3rd and morning of 4th there was a heavy fall of snow. For the rest of that week there was clear, hard weather, with occasional snowfalls, and the afterglow disappeared entirely, the sun rising and sinking quite clearly.

2. On the morning of Sunday, Dec. 9, the weather changed, the snow melted and rain fell. In the evening the afterglow was visible again, commencing about fifteen minutes after the sun had set, and continuing for nearly an hour. This time I observed that the colour of the sky overhead was not red, but of a brown orange tint, and it also seemed to be more scattered. This morning (10th) there was a beautiful "preglow," which was observed about an hour before sunrise, the colours being the very same as those of the evening before.

3. I have observed that a very black bank of cloud usually stretches along the horizon, from west to east, whenever a glow is visible. The upper edge of this cloud is very remarkable, being extremely straight, and pointed towards the west.

Now, I would like to ask a few questions. Could the rays of the young moon (which was high in the sky at sunset last week) have affected the glow and rendered it invisible? Could the rain or the snow have brought the dust nearer the earth, and so account for the orange colour visible overhead last evening, the orange rays being shorter than the red? or could the phenomenon be attributed to ice-particles floating in the higher regions of our atmosphere?

James B. Findlay.

SUN-SPOTS AND COMET.

[1059]—It may interest some of your readers, who have not good telescopes, to know that a large number of spots can be seen with only a small instrument. I use a telescope only 1 ft. long, with an object-glass 1 in. in diameter; on forty days on which I have been able to observe—from Oct. 21 to Dec. 11—I have seen about 150 different spots; on three days, Dec. 4, 5, and 6, no spots were visible. On Nov. 14, 18 were visible; to-day (Dec. 11) 12 are visible, of which three can be seen by the naked eye.

The comet has been visible to the naked eye for about a fortnight.

Northcote W. Thomas.

COINCIDENCES.

[1060]—I think the following adventures of a bank-note equal the wanderings of your correspondence as recorded in Knowledge of the 16th inst. A subordinate in a Government office stationed on an island off the coast of Ireland was entrusted with a bank-note for which he was to get cash at a bank on the mainland. He crossed the water, paid some visits to other offices where he had letters to deliver, and arrived at the bank only to find that the note was gone. Inquiry was made at the offices where he had called, but no trace of the note could be found, and Timothy (for so I will call him) returned almost in tears to the island. Every effort was made to discover the missing note—for no one doubted the honesty of the subordinate. The priest even mentioned the circumstance at the services, which amongst a Catholic community sometimes has a result. To make a long story short, the note remained undiscovered for six months, when one day it was received

by another subordinate (call him Brown), serving in another department on the island, enclosed in a letter from his son in England. The adventures of the note then came out. Timothy, being a careful man, had put the note in an ordinary official envelope, headed "On Her Majesty's Service," and deposited both in his pocket. In delivering his letters at one of the offices on the mainland he had drawn out the envelope containing the note, which fluttered to the floor, and lay there for some time unobserved. The office-keeper, in cleaning out the office next morning, picked up the envelope, and seeing it was an unused one placed it in the stationery-rack with others of the same sort. Brown, who represented this office on the island, found in time that his stationery had run out, and sent over to the head office for more. A supply was made up, and included the identical envelope which still faithfully guarded the note. Subsequently Brown had occasion to write to his son, and not having a private envelope at hand took an official one, picking out the one in which the note still lay undiscovered. The son on opening the letter found the note, and, being an honest lad, returned it to his father. The points that strike one as remarkable in this incident are—1. That the envelope should have been dropped by Timothy without any one noticing it. 2. That it should lie unobserved till found by the office-keeper. 3. That he should not have looked into it. 4. That it should have gone back to the island. 5. That Brown should have used it for a letter going to England. 6. And that he should not have discovered the note. I may add that the note must have had hundreds of escapes from falling into dishonest hands.

C. A. E.

[1061]—Your article on coincidences reminds me of one which you may be glad to add to your list. It is striking, literally, to say the least.

An uncle of mine was a rather fine amateur painter, and as he always presented his pictures in handsome frames, his gifts were usually very acceptable. One of them went to the country, I need not say where, but miles away from the town in which he lived, and was placed in the gentleman's drawing-room, which happened to be over the dining-room. One day whilst at luncheon the family were aroused from their meal by a tremendous report of a falling body in the room above, immediately followed by the crashing of glass. Hastily rushing upstairs into the drawing-room, they found the picture had fallen in such a peculiar manner as to scarcely injure the lower part of the frame, but to utterly smash —more especially in one spot—the uppermost portion. The owner remarked to his wife how strange the picture should have thus fallen to cause so strange a fracture, and added he hoped nothing could have happened to the donor, which idea was laughed at by others present. . . . . That day, and that hour, and as near that minute, my uncle fell down in a fit in the street, not injuring his feet or legs, but striking the curbstone, fractured the skin of his head, and well-nigh his frontal bone—he died at once.

ANOTHER F.R.A.S. SUBSCRIBER.

SILENT LIGHTNING.

[1062]—With reference to letter 1003, p. 308, in the evening of June 29 last I watched the path of a heavy thunderstorm from S.W. to N.E., which at its nearest point was about ten miles distant. As the thundercloud covered a large area, and the lightning was at different points, I was unable to estimate the exact limit of audible thunder, but at 8 p.m., and for ten minutes later, the thunder of every flash was distinct, and I judged the limit roughly at fifteen miles. The wind here was light, from S.W. The lightning was seen, as is frequently the case here, long after the thunder ceased to be heard. The direction and force of the wind seem to affect the distance of hearing.

Rectory, Worcester. F. S. L.

SILENT LIGHTNING.—LUMINOSITY OF ANIMALS.

[1063].—I have met with two remarkable instances of long-continued lightning, unaccompanied by thunder. Once, at Shanghai, in July, the sky was illuminated with one incessant unintermittent glare, lasting several hours, but no thunder was heard. But the most remarkable instance occurred in May, off the south-coast of Madagascar, when, from 7 to 11 p.m., I watched a glare, which left the sky dark only for a second once in an hour or so, the central point of which seemed elevated 10° or 15° above the horizon. As the nearer clouds cleared away, I watched for hours the unceasing flashes, tongues of fire darting out round the distant clouds, radiating in five or six distinct streams of flame from a given point, like the thunderbolt in the hand of Jove, coursing along the sky, or dashing down into the sea at the horizon like liquid fire; yet all the while not a sound was heard. After I had retired, at 11, I still saw, as long as I lay awake, the reflection playing upon the walls of the cabin as from a flickering lamp. The day following was marked by a brilliancy of atmosphere and freshness of temperature not before experienced. On this, and another occasion at Sarawak, the lightning was unusually vivid, but the flashes were not simple instantaneous sparks, but had the appearance of liquid fire poured from a vessel in a continuous stream, and lasting a definite time, during which the lightning vibrated upon the retina, the zigzag form of the flash, however, being meanwhile perfectly retained.

In my "Rambles of a Naturalist in the China Seas" may be found a chapter upon the Luminosity of Animals, the result of many months' continuous observation, containing also suggestions as to its origin. The chapter ends with this remark: "If we were called upon to specify in what classes of animals it (luminosity) has been observed, we should prefer to make a converse statement, to the effect that, with the sole exception of birds, every class of animals includes representatives, which, under certain circumstances and conditions, have been proved to be capable of giving out light."

C. COLLINGWOOD.

FIGURE MAGIC—CURIOUS MULTIPLICATION.

[1064]—Taking first the case where nothing is added (letter 974, page 262), it is easily seen that multiplying by 3 and 3 and dividing by 2, 2, and 9 is equivalent to dividing by 4 $\left(\text{for } \frac{3\times3}{2\times2\times9}=\frac{1}{4}\right)$ which accounts for the final multiplication by 4 in order to arrive at the original number. The example given (in which the first of the "trebled results" is odd) is rather more difficult to unravel. A little consideration, however, shows that the 1 added is subsequently multiplied by 3 and divided by 36, and the resulting $\frac{1}{12}$ is discarded in the $\frac{1}{4}$ after dividing by 9 ($93\frac{1}{4}$ being the full quotient). It is therefore evident that after multiplying by 4 the result is $(\frac{1}{4}-\frac{1}{12})\times4=1$ too little. Hence the necessity for the final addition of 1.

It follows from the rule that any similar example (*i.e.*, with first odd and then even trebled results) must have a remainder with a fraction of $\frac{1}{4}$ after dividing by 9. From which we can infer that only those numbers will yield first odd and then even trebled results, which, when multiplied by $\frac{3\times3}{2\times2\times9}\left(=\frac{1}{4}\right)$, and increased by $\frac{1\times3}{2\times2\times9}\left(=\frac{1}{12}\right)$, give a remainder with a fraction of $\frac{1}{4}$. Deducting the $\frac{1}{12}$ the fraction is $\frac{1}{4}$; therefore the numbers which will yield odd and then even results, are those which are one in excess of the multiples of 4. Similar considerations will show the reason for the cases in which 2 and 3 are to be added.

I should like very much to learn how "A. B." arrived at his curious rule for multiplication in certain cases (letter 973). It seems to have some connection with the ordinary *working* of multiplication, as may be seen by writing down his working as follows:—

36585
53658
85365
58536
65853

726,175,665

It also seems to have a relation to the well-known fact that any number whose digits, when added together, make a multiple of 9 is itself divisible by 9; for the multiplicand and product in each example are multiples of 9. Perhaps "A. B." *first* invented his rule, then applied it to a number of multiples of 9, picked out those cases in which the product was also a multiple of 9; divided the products by the multiplicands, and thus obtained multipliers from which he selected those which had no fractions. Thus he might have taken 18, multiplied it according to his rule, getting 828, and dividing this by 18; thus arriving at 46 for the multiplier. But 27, 36, &c., yield multipliers with fractions.

Dulwich, *Nov.* 5, 1883. CHAS. E. BELL.

LETTERS RECEIVED AND SHORT ANSWERS.

HENRY CLARK, SUBSCRIBER. (Truly as you say what *was* the gun made of.)—T. S. B., H. B. H. Path straightest when moon *new*, most curved when she is *full*.—R. HILL. Have read your lines with much pleasure and sympathy.—H. MOULTON, C. L. TWEEDALE. Far too complex for treatment here.—ALEX. ZEITGOR A. To what fighting would you invite readers!—CR. TAYLOR. Thanks. Author unknown to me. Will forward.—C. SMITH. We do not send reporters to lectures.—JUSTITIA FIAT. Many thanks; but *why* should

I look up Mr. Ruskin's remarks about me? You tell me they are wanting in grace and courtesy. Has either quality been shown in anything Mr. Ruskin (or rather he who was Ruskin) has published for the last five years? Were the remarks now by my elbow I should hardly deem it worth while to turn to them. Do we not know the tone? He now groans constantly about some one. Tyndall and Darwin, Spencer and Carlyle, have had their turn: no one but Mr. Whistler ever took any notice. Why should I?—J. W. S. Please send.—E. Wells. Have tried to do as much in my little work (published by the S.P.C.K.)—H. H. Many thanks.—A. M. Mitchison. Shortly: see "Gossip."—J. C. Bryant. That writer is a "her," not a "him." Your letter reserved for publication.

Our Chess Column.

By Mephisto.

THE BOOK OF THE TOURNAMENT.

Third Notice.

Arranged according to openings, the 242 games of the Major Tournament rank as follows:—

Irregular	63	Three Knights	4
Ruy Lopez	51	Steinitz Gambit	4
French	50	Scotch Gambit	4
Giuoco Piano	18	Evans Gambit	4
Sicilian	17	Miscellaneous	20
Four Knights	7		

The term "irregular opening" is somewhat too vague. By far the largest proportion of these games were Queen's side openings, that is, where the ultimate development of the opening proceeds on the Queen's side, although the first moves may vary, as, for example:—1. Kt to KB3, as frequently played by Zukertort; or 1. P to QB4, called the English opening; or 1. P to K3, practised by Mason; or 1. P to Q4, leading to the Queen's gambit, and favoured by Steinitz. Most of these openings led to similar and well-known positions. A few games were opened with 1. P to KB4, mostly by Bird, while but very few games were irregularly opened, in the real sense of the word.

Over 200 of these games were began with *safe* openings. The gambit was adopted in only about twenty cases. The Ruy Lopez deservedly heads the list of regular openings.

Zukertort's games—annotated by himself—furnish an interesting study of this opening. Game 14, between Winawer and Zukertort, brings matters to a crisis in a main variation of this opening, as the game will show:—1. P to K4, P to K4. 2. Kt to KB3, Kt to QB3. 3. B to Kt5, Kt to B3. 4. Castles, Kt takes P. 5. P to Q4, P to QR3 (analysed by Professor Berger, of Giaz, and superior to B to K2, for which move *vide* Game 13, between Zukertort and Winawer). 6. B takes Kt (6. B to Q3, instead, would be met by P to Q4. 7. P to B4, B to KKt5, &c.) QP takes B. 7. Q to K2, B to KB4. Winawer here continued with 8. P to KKt4, which, however, did not lead to any superiority of position. Zukertort here gives 8. P takes P, remarking that this would about equalise the game, in which case, of course, the attack of the first move has failed. This failure confines the attack within narrower limits, *i.e.*, 1. P to K4, P to K4. 2. KKt to B3, QKt to B3. 3. B to Kt5, Kt to B3. To avoid the former variation, White can only continue with either 4. Kt to B3, leading into a tame variation of the Four Knight's Game (*vide* Game 4 between Mackenzie and Zukertort), or 4. P to Q3, which is the stronger move, and was played against Zukertort in Game 19 by English, of Vienna, who is acknowledged to be a thorough master of the Ruy Lopez. Now in order to defend the threatened KP, Black has, apparently, only one good move, that is 4. P to Q3 (4. B to B4, adopted by Rosenthal against Steinitz, *vide* Game 57, is not considered good by the latter player). After 4. P to Q3, P to Q3, English continued as follows against Zukertort:—5. Kt to B3, P to KKt3. 6. P to KR3, B to Kt2. 7. B to K3, B to Q2. 8. Q to Q2, P to KR3. 9. Castles, KR, and White has a superior development. Zukertort here suggests for Black 9. P to KKt4, to be followed by Kt to K2 and Kt3, but we think even then White would obtain a good game by 10. P to Q4, &c. Zukertort must have been of the same opinion, for he never again faced this variation, but became a convert to the defence of 3. P to QR3 in preference, which he adopted in all his subsequent Ruy Lopez defences, *vide* Game 25, against Steinitz; Game 26, against Winawer; Game 29, against Rosenthal; and Game 30, against Mackenzie.

SOLUTIONS.

Problem, No. 108, by B. G. Laws, p. 340.

Author's Solution.

1. Kt to Kt8	K to Q4, or	1.	K to Kt4
2. Q to KR7	any move	2. Q to QB7	anything
3. Q mates accordingly		3. B to Q3, mate	
1.	P to Q4	1.	P to B6
2. Q to QB7(ch)	K to Q5	2. Q to QKt7	anything
3. Q takes P, mate		3. Q mates accordingly	

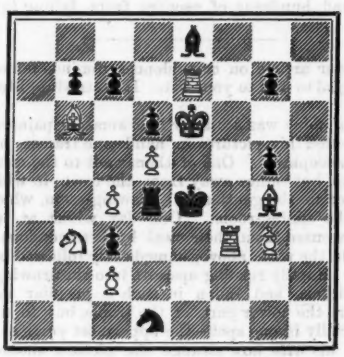
Problem, No. 109, by C. Planck, p. 354.

1. B to Q6	P takes B	1.	K takes Kt (*a*)
2. Kt to B3(ch)	K to B4 (*a*)	2. Q to K5(ch)	K to B6
3. Q to Kt sq, mate		3. Q to K2, mate	
	(*a*) K to K3		(*a*) K to K3
3. B takes P, mate		2. B to QB4(ch)	K to B4
		3. Kt to Kt3, mate	

PROBLEM No. 110.

By Henry Bristow.

Black.



White.

White to play and mate in two moves.

ANSWERS TO CORRESPONDENTS.

*** *Please address Chess Editor.*

J. Canaway.—Castling is not allowed in Tourney Problems, and is not resorted to by most composers.

Berrow, W.—Solutions correct.

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